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# REPORT OF THE SCIENTIFIC AND TECHNICAL ADVISORY PANEL BRAINSTORMING ON PERSISTENT ORGANIC POLLUTANTS

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(Prepared by the Scientific and Technical Advisory Panel)

# Report of The STAP Brainstorming on Persistent Organic Pollutants

**Bridgetown, Barbados**
**21-22 February, 2000**

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*The Scientific and Technical Advisory Panel (STAP)*
*Of the Global Environment Facility (GEF)*

**STAP Secretariat**
**United Nations Environment Programme**

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## PREFACE

It is a pleasure to present the final report of the STAP Brainstorming Session on Persistent Organic Pollutants (POPs). The Brainstorming Session was held on February 21-22, 2000 in Bridgetown, Barbados. The meeting was convened by the Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF) to consider the issue of persistent organic pollutants with the view of advising the GEF of the opportunities for GEF interventions.

This report was prepared by Prof. Angela Wagener with inputs from the STAP Secretariat.

Prof. Madhav Gadgil
STAP Chairman

## EXECUTIVE SUMMARY

This report is the result of the STAP Brainstorming Session convened in Bridgetown, Barbados from February 21-22, 2000. The goal of the session was:

*(i) To explore the issue of persistent organic pollutants with the view of identifying approaches and opportunities for GEF interventions ;*

*(ii) The identification of gaps and potential targeted research areas needed to scientifically and technically underpin future GEF interventions.*

The discussion centered on a wide range of issues (use, fates and effects on the environment, including effects on biodiversity and land degradation, the state of monitoring, prevention and redemption, existing options, socio-economic aspects) which are relevant for understanding the scope of POPs and which are likely to have implications for the implementation of the International Convention on POPs currently under preparation. The discussion highlighted the complexity of assessing effects on ecosystems and the constraints associated with the existing methodologies (lack of sufficiently sensitive and discriminatory instrumental, analytical techniques and authentic standards for compounds that occur in wildlife) to investigate POPs, its metabolites and decay products.

A number of general conclusions and recommendations were made taking into account the range of problems that must be overcome in developing countries and countries with economies in transition before attaining the goals of reducing or eliminating persistent toxic chemicals. These are summarised as:

*(i) Mechanisms should be put in place to assist countries in building capacity to negotiate POPs reduction and elimination and to implement management policies ;*

***(ii)*** *There is a need to establish monitoring activities to reduce data gaps, to produce time series data, evaluate environmental status and provide input data essential to chemical fate modeling ;*

***(iii)*** *The implementation of environmental assessments directed to obtain reliable data, and "clearing house "practices are imperative to reduce data gaps ;*

***(iv)*** *The need for the establishment of training programmes and mechanisms to facilitate technology transfer to developing countries as tools to address the need for Persistent Toxic Substances (PTS) exposure information ;*

*(v) Incentives to the implementation of Integrated Pest Management (IPM) are imperative to reduce PTS emission from agriculture sources ;*

*(vi) Appropriate technologies must be made available to deal with old stocks in specific conditions, as for example, those existing in some African countries ;*

(vii) *Implementation of BEP and BAT to reduce emissions as well as the establishment of incentives (or penalties) to improve industry maintenance and operational practices is needed to reduce industrial emissions ;*

Information gaps and potential targeted research areas were also identified. These included *inter alia* gaps regarding monitoring and assessment ;biological effects ;stock piles ;persistent toxic substance management ;wildlife species sensitivity issues.

The implication of the ongoing POPs negotiations for GEF operations and the scientific and

technical requirements needed for a holistic approach were considered with the context of the existing GEF framework, namely, Operational Programme 10, for addressing POPs. A number of specific recommendations were made. These include:

- *The UNEP's Regionally Based Assessment of Persistent Toxic Substances should be used as a basis for selecting potential chemicals as candidates for GEF interventions. This implies:*

*(i) The adoption of a more flexible definition of Persistent Toxic Substances (PTS) in which persistent and "mobile" substances may be listed as substances that are less inherently persistent but that lead to continuous exposure because of their constant release in the environment and wide spread use (ubiquity);*

*(ii) To consider exposure patterns in defining relevance; and*

*(iii) To use chemical, ecotoxicological and human toxicological information.*

- *The GEF, in dealing with chemical contamination should make use of regional prioritisation, looking for historical and cultural aspects when selecting important substances that will have to be dealt with at a regional level.*

- *Operational Programme 10 "Contaminant-Based Programme" as currently written does not allow for a GEF response on a country by country basis though actions in context of POPs will have to be taken at country level. The restriction related to country-based action, means as for today relying on replications, an approach that shall inhibit GEF performance when undertaking a problem that is characterised by a diversity of peculiarities (country based: modes of use and storage of old stocks, different exposure routes, cultural and political context, etc.) and environmental conditions (regional aspects but in some cases country based). Dealing with the requirements of the POPs convention under OP 10 may restrict GEF actions in other issues of water contamination which are at least as important in developing regions. Some examples are chemical and pathogenic contamination of waters derived from sewage releases.*

- *A revision of OP 10 is recommended in the direction of:*

  *(i) keeping the broad scope of GEF interventions in dealing with PTS other than the 12 POPs, and*
  *(ii) giving more emphasis to ephemeral contaminants (nutrients, etc) which are equally or even more damaging to the marine environment.*

- *That a new OP be put in place to deal exclusively with the requirements emerging from the POPs Convention, in the event that GEF becomes the financial mechanism for the Convention. Such an OP should provide flexibility of action and a broad scope of interventions (addressing: human and environmental health issues, land and water ecosystems, technical and socio-economic aspects, actions on the ground for elimination or substitution).*

- *For an appropriate range of POPs/PTS issues to be addressed, the effects of this class of*

*substances could not be limited to water pathways of exposure. For POPs/PTS to be dealt with holistically, all pathways of transport and exposure would need to be deemed relevant for GEF interventions. In addition, water is taken as the single pathway of exposure while in the case of POPs other routes are of far greater importance, and effects on land biota are not at all considered.*

- *Though it was recognised that, for the purposes of the POPs convention, such additional substances would be those accepted by the Parties to the Convention, it was not considered desirable that a specific persistent toxic substance be identified for the purposes of defining their eligibility for GEF intervention, but instead the broad definitions of criteria for substances to be considered as PTS would suffice. Broadly inclusive criteria such as, persistence (e.g > 6 months in soils)*; bioaccumulation (e.g. log $k_{ow}$ > $10^3$)* and promoting adverse effects in humans or animals, should be considered.*

## SECTION 1: INTRODUCTION AND BACKGROUND

### 1.1 Introduction

STAP in its report[1] to the GEF Council in 1998, identified Persistent Organic Pollutants (POPs)[2] as an emerging issue which STAP should address in GEF II. In addition, the recently established Intergovernmental Negotiating Committee (INC)[3] with the mandate to prepare an internationally legally binding instrument for implementing international action on certain POPs, have greatly increased the potential of GEF interventions in this area. Among the first twelve substances which are the focus of the INC included manufactured products, such as polychlorinated biphenyls (PCBs) and hexachlorobenzene (HCB), unwanted by-products (examples are polychlorinated dibenzo-dioxins and polychlorinated dibenzofurans (PCDD/PCDF) for both (examples are PCB and HCB, which are also formed in combustion processes).

In addition, the need to develop science-based criteria and a procedure for identifying additional POPs as candidates for future international action has been recognised by the international community[4]. Based upon the work of the Criteria Expert Group set up by INC 1 and responses received from countries, the following parameters have been identified as being of primary interest to identify further POPs:

(a) **Persistence**: The ability to resist degradation in various media, such as air, water and sediment, measured as half-life of the substance in the medium. Evidences of persistence are: half-life in water greater than two months, or half-life in soils greater than six months, or half-life in sediments greater than six months, or substance sufficiently persistent to be of concern within the scope of the POPs Protocol.

**(b) Bioaccumulation**: the ability of a chemical to accumulate in living tissues to levels higher than those in the surrounding environment, expressed as the quotient between the concentration in the targeted tissue and the environmental concentration.

**(c) Potential for Long Range Transport**: A potential for transfer to a receiving environment in locations distant from the sources of release of the substance. Transport can be by air, water or migratory species.

**(d) Toxicity and Ecotoxicity**: There is evidence that toxicity or ecotoxicity data indicate the potential for damage to human health or to the environment. This criteria was proposed but is not yet adopted.

The potential importance for this area for the GEF was further highlighted at the Fourteenth meeting of the GEF Council held in December, 1999 when it requested that an

[1] UNEP: Priority Issues which STAP Should Address in GEF II, September, 1998.

[2] Persistent Organic Pollutants (POPs) are hazardous chemicals that resist degradation by physical, chemical or biological pathways, bioaccumulate through the food web and pose a risk causing adverse effects on human health and the environment. There has been growing international concern that releases and emissions of POPs may endanger significant parts of the biosphere as well as human populations.

[3] The INC is focusing on twelve specific persistent organic pollutants, namely Aldrin, Chlordane, Dieldrin, DDT, Endrin, Mirex, Toxaphen, Hexachlorobenzene, PCB, Dioxins, Furans.

[4] UNEP Governing Council 19th Session

assessment be made of the implications for GEF activities of the negotiations on persistent organic pollutants.

Taking into consideration the range of problems[5] that must be overcome before attaining the goals of reducing or eliminating persistent toxic chemicals in developing countries and in countries with economies in transition, and the potential for GEF interventions in this area, STAP organised a brainstorming session on POPs on February 20-21, 2000 in Bridgetown, Barbados.

### 1.2 Aims and Objectives

The aims and objectives of the brainstorming session were outlined as:

(i) To explore the issue of persistent organic pollutants with the view of identifying approaches and opportunities for GEF intervention.

(ii) The identification of gaps and potential targeted research areas needed to scientifically and technically underpin future GEF interventions.

### 1.3. Structure of the Meeting

The meeting was structured to cover a wide range of issues (use, fates and effects on the environment, including effects on biodiversity and land degradation, the state of monitoring, prevention and remediation, existing options, socia-economic aspects) which are relevant for understanding the scope of POPs and which are likely to have implications for the implementation of the International Convention currently under preparation.

Scientific presentations were made on issues such as the global and regional significance of POPs: environmental and human health aspects; modelling and forecasting POPs, environmental distribution and fate in developing countries; monitoring biological effects using biomarkers: economic and technical advantages and limitations; policy and options for Persistent Toxic Substances (PTS) use in agriculture and vector control; and availability of techniques to reduce emissions of non-pesticide PTS. In addition, discussion groups addressed topics such as: monitoring and research needs; stock management, behaviour and fate assessment needs; and should the GEF interventions go beyond the "12 dirty chemicals" presently the consideration of the INC. The outline of the brainstorming's agenda is continued in Annex 1.

### 1.4. Participation

The meeting was attended by experts from various countries, three members of STAP, and representatives from the GEF Secretariat and the Implementing Agencies (See Annex II for the list of participants).

[5] In general, there are data gaps related to sources intensity, source characterisation (old stocks, dumps, illegal trade, abuse and misuse etc.), poor knowledge of degradation rates and other scientific information that may be relevant to assess persistence, transport and toxicity in tropical climates, lack of scientific expertise to conduct environmental evaluation, lack of regulations and institutional capacity to fully address the problem, lack of information on options, lack of awareness, etc.

## SECTION 2: SCIENTIFIC AND TECHNICAL DIMENSIONS OF PERSISTENT ORGANIC POLLUTANTS AND PERSISTENT TOXIC SUBSTANCES

### 2.1 Introduction

A comprehensive overview of the scientific and technical issues underpinning the consideration of POPs and PTS was presented. It was recognised that the transboundary movement of these substances (through natural and man-made pathways), the worldwide use in agriculture and transference of industrial activities to cheap labour countries, pose a threat to populations and environments of world regions least prepared to tackle the adverse consequences. The changes that the actual list of twelve chemicals that are being considered by the INC, with the mandate of preparing the international legal binding instrument, will increase. The number of synthesized chemicals is now beyond 3 million and is growing at a rate of several hundred thousand a year of which 300-500 reach the stage of commercial production. It is estimated that up-to one-third of the total production of these chemicals reaches the environment.

The following is a brief summary of some of the main issues highlighted in the presentations.

### 2.2 Status of Negotiations on POPs: Implications for the GEF

An update of the negotiations for an international, legally binding instrument for POPs was provided by a representative from the Convention Secretariat. It was emphasised that there is a need to assist countries in building capabilities to negotiate POPs reduction and elimination and to implement management policies. It was also observed that appropriate technologies must be made available to deal with old stocks in specific conditions, such as those, for example, encountered in some African countries.

In summarising the status of contaminants in the context of the GEF it was noted that interventions are presently restricted to the water context[6] under Operational Programme 10 entitled *"Contaminant-Based Programme"*. The fact that persistent toxic substances are only dealt with under OP10, restrict the scope and possibilities of action that otherwise could be taken in order to meet the needs of several regions. A specific problem of tropical countries, for example, arises from the use of pesticides in vector control (malaria and others), a practice that affects directly humans and land habitats directly, but not always causes alteration in aquatic life. It was however, stressed that the major pathways of exposure of humans and land animals do not all include marine or freshwater components. In addition, a listing of POPs and the properties that led to the selection of the 12 chemicals as being an issue of global concern was also presented. It was noted that concern is rising about other persistent substances as well as about chemicals that, although less persistent, are in widespread and continuous use and therefore may pose chronic exposure over large scales.

[6] GEF's contaminant portfolio includes presently one full project already under implementation (regionally based assessment of PTS) and three PDF projects (reducing pesticide runoff in the Caribbean; POPs' food security and indigenous people in Artic Russia; persistent toxic substances – country case studies).

## 2.3 Global and Regional Significance of POPs

### 2.3.1 Environmental Aspects

The complexity of assessing effects on ecosystems and the constraints associated to the existing methodologies (lack of sufficiently sensitive and discriminatory instrumental, analytical techniques and authentic standards for compounds that occur in wildlife) to investigate POPs, its metabolites and decay products was emphasised. In the case of dioxins, for example, in many instances only sophisticated analytical methodologies are acceptable to determine levels in the biota and in the physical environment. The high costs and the necessary high degree of expertise so far as they are required in the environmental assessment of those substances are important factors to be considered when programming activities in developing countries.

The positive environmental response after eliminating DDT, PCBs and reducing dioxin and furan emissions in the Great Lakes region where levels of these substances are decreasing in fish and wildlife was demonstrated. Although this decreasing trend is encouraging, recent data suggests that the rates of concentration decrease have declined for PCBs and DDE (a decay product of DDT) due to internal recycling and continued input, especially from atmospheric deposition. Concentrations of these substances cannot be expected to decrease further very rapidly. While concentration of the routinely measured contaminants have declined, effects such as skeleton deformities, reproductive failure and immune suppression are still observed. Field and laboratory data indicate that lethality and deformities in fish-eating water birds are caused by the toxic effect of multiple compounds. Additive models must still be developed to allow forecasting threshold concentrations for a chemical in the presence of multiple stressors. More must also be known on species sensitivity and exposure assessment.

In general, a decline of these substances in industrialised countries has been observed, however, there are regions still with high environmental levels. Because screening studies in developing countries are very scarce there are serious data gaps on concentration levels in the biota and in the physical environment. As a consequence, the urgent need for development of cheaper and reliable methodologies and techniques to assess levels and effects of POPs in the environment and the need to improve communication between scientists and policy makers was recognised. It was also noted that implementation of appropriate environmental policies are frequently procrastinated because policymakers have difficulties in dealing with the uncertainties that are inherent to scientific findings.

### 2.3.2 Human Health Aspects

The complexity of assessing effects of POPs on humans was highlighted. However, it was recognised that many of the environmental aspects of POPs are also relevant to human health considerations.

The exposure pathways are the processes by which DDT may be transported from the pollution source to the living organism. The high persistence of POPs, coupled with the amount of these compounds used in different countries, provides the necessary conditions for POPs to become contaminants of global concern. Additional investigation is needed to characterise the specificity in tropical regions where biogeochemical behaviour may differ from that observed in temperate regions, and to identify exposure pathways in particular scenarios as, for example, malaria areas and hazardous waste sites.

Special efforts are required in the development of new methodologies for exposure assessment in susceptible population like children, indigenous women and fish eaters. Research on population has, for the most parts, addressed adults, however, recent findings are indicating that children exposed to DDT develop serious neurological problems. The comprehensive assessment to DDT and its metabolites toxicity requires specialised analytical infrastructure and capability in order to identify and quantify different isomers and enanctiomers. Furthermore, appropriate methodologies are needed for the analysis of dioxins and furans in developing countries, and in this regard, ELISA techniques are promising tools that warrant additional research. Availability of low cost and easy-to-apply methods is a key factor in development of surveillance programmes and in the necessary studies of the biological effects of pesticide mixtures.

### 2.3.3 The Uses and Misuses of Pesticides POPs in Agriculture and Vector Control

A critical issue in the context of the global and regional significance of POPs addressed by the meeting, related to the uses and misuses of pesticide POPs in agriculture and vector control, the environmental problems associated with these applications and the limitations that may exist for introduction of other options. In developing countries, pesticide uses are often times quite different from that for which the product was originally devised. Besides the use in agriculture to control pests and exterminate alien plants as well as in vector control, uses on bird control, fish killing, and even human birth control have been reported. Often there is incorrect use in agriculture as well as in prevention of diseases resulting in additional, unnecessary contamination of soils, waters, biota and humans. Existing old stocks which are not properly isolated and illegal trading of substances which have been banned in several countries are additional threats to the environment in developing nations.

The environmental impacts derived from pesticide uses will depend on regional environmental conditions and properties as well as on use pattern. In many tropical regions soils are poor in organic matter (for example, in South Africa carbon content can be as low as 0.1%) and present low microbiological activity. Under this condition some new pesticides considered degradable may indeed have long half lives in soil and may also be leached down or laterally to nearby water bodies. In many cases continuous exposure to a principally degradable pesticide derived from frequent use leads to the observation of toxic effects and environmental risks which are similar to POPs pesticides.

The implementation of alternatives to POP pesticides requires further evaluation. Little is known about the risks derived from the constant exposure, as in the case of indoor pest control. The accumulation of pyrethroids in human milk, for example, and the possible effects on children are still unknown for this substance and for many of the new chemicals already in use. Little is known also on the synergistic effects that may cause adverse reactions in humans and on the biota from the combined presence of the old chemical (for example, DDT and its metabolites) and the new pesticides. The choice for a certain option requires careful evaluation not only of possible adverse effects and cost effectiveness but also of the efficiency and reliability of the selected chemical. Failure in sustainability of both these properties may lead to impairments in maintaining confidence related to vector control programmes at the community level. A periodic review of pesticide use in pest control is highly recommended.

There are no incentives for the implementation of Integrated Pest Management (IPM) although it represents an interesting option for agricultural purposes. There are also advantages in integrating IPM and Integrated Vector Management (IVM).

## 2.4 Modelling and Forecasting POPs

### 2.4.1 Modelling

An overview of the state of the art of modelling environmental distribution and fate of POPs as well as the data requirements and developments needed for application in tropical areas were presented.

A model based on a system consisting of air, water, soil and sediments in which there is also treatment of sub-compartments such as aerosols in air and solids in water captures the principal phases of accumulation and transport at least for most chemicals and environmental conditions. There is a fairly good predictive capability for phase partitioning coefficients of most chemicals with exception of some classes of polar compounds and media, such as vegetation. Models are essential to describe inter-media transport because chemical fluxes cannot be measured directly and must be derived from measurements of related transport processes. Mass transfer coefficients or deposition velocities that are encountered in a certain environments must be available for appropriate modelling. Modelling is also useful in estimating persistence in the environment (the definition includes all irreversible losses) and for this simple Level III multi-media models are available. Persistence is the property of resistance to degradation but is also related to the response to source reduction.

Persistence and long distance transport are related in the sense that time is required for transport. The task of assessing information on new or existing chemicals requires major data collection at each targeted site. As an alternative a classification system is proposed based on chemical properties (for example, half lives in specific media and inter-media partitioning coefficients) that allow to classify a chemical as persistent and as having the potential for long range transport. Other essential data to ensure best model outputs refer to loads, emissions, fluxes, environmental properties and concentrations, degradation rates in different media and mass balances. Availability of reliable data is a fundamental requirement. Uncertainties, for example, in forecasting degradation rates which are dependent on the chemical properties as well as on the environmental properties, pose difficulties in calculating externalities.

Through modelling and from known fluxes and concentration data in sediment and water, it is possible to estimate the amount of a certain substance originally released in a given environment.

### 2.4.2 Monitoring

Monitoring, defined as long-term standardised measurements and evaluations, is a fundamental tool in the evaluation of persistence and long range transport and has been essential in the discovery and understanding of the environmental behaviour of POPs. A continuous annual sampling programme is required to define temporal concentration trends in the environment. From other side, equilibrium models are powerful tools in helping to programme monitoring activities. It is evident that collaboration between environmental and modelling scientists is a key element for defining input parameters in multimedia models and shall benefit both

segments. In this regard, additional information can be obtained from known chemical properties, for example, the ratio between substances (parent molecule versus metabolite concentration) present in sediments or in the biota may give information on the age of contamination.

In developing countries scarcity of information on loads and emissions, persistence and degradation in different media, the lack of monitoring data, and therefore of time series data, as well as problems of precision and reliability of existing data may impair the effective use of models as a tool to understand inter-media transport.

A new approach in monitoring activities that includes the use of biological markers was presented. Traditionally monitoring activities have been based on the observation of variations on chemical properties, especially concentrations in the several environmental media. The costs and high proficiency requirements of this approach are two major constraints to the establishment of effective and long lasting monitoring programmes. The biomarkers approach which is based on the observation of biological or biochemical responses in different organisms derived from environmental changes utilises, in general, low cost assessment techniques that can be easily replicated. In addition, they provide a direct measure of the extent of ecological impact at the individual, population and community level.

Biological markers are not specifically indicating exposure to a single chemical, they are rather expressing the result of an integrated response of the organisms to the chemosenosis and produce information on the general status related to neurological, nutritional, hormonal, genetic and immune conditions. By using a hierarchical approach, however, it is possible to conclude what class of chemicals are causing the observed effects.

Biomarkers maybe very useful in the rapid assessment of the marine pollution whereby the identification of biological effects are used for a fast survey on evidences of environmental disturbances. Once such evidences are localised only then can more sophisticated techniques be put in place to trace back which chemicals are responsible for the observed reactions.

There are some methodologies based on biomarkers currently in use, as for example: the measurement of metallothionein levels in mussels and other organisms as an indicator of stress derived from contamination of sulphur binding trace metals; the measurement of variations in the production of cholinesterase in crabs as indicator for contamination by organophosphorus pesticides; the neutral red test that indicates general stress levels in mussels and other organisms, etc. The developments in the field have been very encouraging, indicating the elevated potential of the technique as a reliable and cost effective approach of ecological relevance.

The promising character of the proposed approach and the possibility of drastic reduction in costs associated to monitoring activities raised broad discussion on the issue. The costs of a conventional GC analysis are of the order of 170 US$ per sample while the estimated costs of screening based on biomarkers can be around 10 to 20 US$ per sample. Immuno-assays are an additional tool in monitoring with associated costs (230 to 60 US$ per sample) lower than the conventional chemical analysis but still higher than that estimated for biomarkers. Both the immunoassay and biomarker tests cannot substitute completely the need for sophisticated chemical analysis but can be used to minimise this need. This can be attained by application in preliminary environmental surveys intended to localise hotspots or to acquire information on

existing biological stresses derived from contamination. The adaptation of the biomarkers approach to the needs of tropical environments as well as the development of new markers constitute an excellent field for GEF intervention under targeted research.

### 2.4.3 Techniques to reduce emissions and to destroy non-pesticide POPs

Industry derived persistent toxic substances can reach the environment by means of releases from several stages of the productive chain, for example: from the import of resources; from manufacturing and combustion processes; from import and export of products, etc. PTS products are mainly released into water and soil through their application and use, while PTS by-products are released principally into the air because the main sources are combustion and thermal industry processes.

Basically three classes of elimination technologies are in existence: mechanical processes that are able to concentrate and prepare the material for safe storage, but do not eliminate the chemical; biological processes which are able to eliminate the chemical via decomposition but are of low efficiency as testified by the fact that these are "persistent" chemicals; and physico-chemical and thermal processes using high technology that are very efficient and effectively destroy the chemical. The cost level of the three approaches is quite different, growing with the efficiency and the technological level required. Demand for specialised man-power is low for mechanical processes and high both in the case of biological and physico-chemical processes.

Restrictions to transferability of existing technologies to developing regions is principally related to costs and personnel resources as well as infrastructure. For example, only six months would be required to eliminate the entire 17,000 tonnes of old pesticide stocks in Africa at a cost of 30 to 40 million US dollars, if the money could be made available. At the current rate of old stock elimination, it will take more than 40 years! Logistics may also impose restrictions on efforts to concentrate or eliminate residues and old stocks.

Best practices to reduce emissions are cost effective options as compared to elimination of the chemical already released into the environment. Improved industry maintenance and operational practices as well as some simple process optimisation may bring surprisingly good results in reducing air emissions, water releases, soil contamination and waste generation. The industrial sector should be stimulated to implement technological improvements in order to reduce environmental costs ultimately shared by the society as a whole.

From the discussions, the importance of developing appropriate economic tools to value environmental assets became clear. Presently, societies are very limited in their capabilities of estimating economic losses derived from contamination as well as from other processes of environmental degradation. This constrain has a direct impact on the building up of environmental awareness amongst the several stakeholders and, therefore, on the implementation of conservation actions.

## 2.5 General Conclusions and Recommendations

On the basis of the presentations and the discussions which followed a number of general conclusions and recommendations were arrived at. These are summarised as follows:

(i) Mechanisms should be put in place to assist countries in building capacity to negotiate POPs reduction and elimination and to implement management policies.

**(ii)** There is a need to establish monitoring activities to reduce data gaps, to produce time series data, evaluate environmental status and provide input data essential to chemical fate modelling.

**(iii)** The implementation of environmental assessments directed to obtain reliable data, and "clearing house" practices are imperative to reduce data gaps.

**(iv)** The need for the establishment of training programmes and mechanisms to facilitate technology transfer to developing countries as tools to address the need for PTS exposure information.

(v) Incentives to the implementation of IPM are imperative to reduce PTS emission from agriculture sources.

(vi) Appropriate technologies must be made available to deal with old stocks in specific conditions, as for example, those existing in some African countries.

(vii) Implementation of BEP and BAT to reduce emissions as well as the establishment of incentives (or penalties) to improve industry maintenance and operational practices is needed to reduce industrial emissions.

(viii) Mechanisms are needed to fasten intervention in the management of stockpiles.

## SECTION 3: INFORMATION GAPS, TARGETED RESEARCH AND IMPLICATIONS FOR GEF

**3.1** There is obviously a great need for a better understanding of many scientific, technical and socio-economic issues with respect to the monitoring, management reduction and/or elimination of POPs particularly in developing countries. The meeting identified the need for the GEF to invest resources in targeted research to assist in enhancing understanding of these issues.

### 3.2 Gaps Regarding Monitoring and Assessment

- **Environmental exposure assessment for POPs in developing countries:** The first and foremost gap in information regarding POPs was determined to be the lack of environmental exposure information in many developing countries. These chemical measurements are needed to determine baseline concentrations of POPs that could be used to better understand global transport of POPs. Further, the chemical measurement of POPs in regions with little or no information could be used to define "hot spots" which may serve as a long-term source of POPs into the regional or global environment. Measurements in abiotic (soil and sediment) and biotic (human food, humans, and wildlife) matrices are required to help define exposure pathways in the environment and their relative importance. It was recognized that the monitoring efforts need to be prioritized based on historic use patterns of POPs and estimates of likely release into the environment. Additionally, consideration must be given to food web exposure pathways based on knowing the ecological linkages when prioritizing monitoring efforts. The biota selected for monitoring should be top predators or reflect an exposure pathway likely to result in maximum exposure due to bioaccumulation of POPs. Priority within these programs should be given to countries with a high estimated potential, based on use patterns, in combination with lack of previous data on chemical concentrations of POPs in the environment. There is a particular lack of this type of information in the Southern Hemisphere.

  **Recommended Action:** It was recognized the financial support required to conduct such an effort would be tremendous and most certainly would exceed the funds available. This would be particularly true given the costs of routine analytical chemistry procedures. Therefore, a two phased action plan was recommended to address the need for monitoring (exposure) information in developing countries. First, support for development of more rapid and cost-effective analytical chemical measurement procedure for POPs is required. This support should go toward a simple and potentially field-based procedure for POPs in the environment. One example of such a procedure, which has proven useful in their regard, is enzyme-linked immuno-absorbance assay (or ELISA). Research and support activities are recommended which would make this and other related methods available at minimal costs. Support for training and technology transfer to persons from developing countries (i.e capacity buildings) is the action recommended to address the need for greater POP exposure information in these developing countries. The basic elements of such training would include: in-situ (in country) training courses; a strong quality control/quality assurance program with performance criteria for the methods (set detection limits, recovery rates, etc); data analysis techniques, metadata requirements; and development of appropriate manuals. This type of program would be most effective if the training was given to a number of people in a given country and there was evidence that

the techniques and training were to be supported in the future.

- **Biological effects monitoring of the environment in developing countries.** Beyond the need for chemical exposure information, more information on the ecological health of various ecosystems in developing countries is necessary. Biological effects monitoring would provide an early warning system, a way to integrate the response of organisms to multiple stressors (chemical and non-chemical) and a reference point for comparison of organism al health over time.

  **Recommended Action:** As with the POPs exposure assessment, the cost of conducting and sustaining such a program would be great. Therefore, the most efficient and cost effective approach to implementation would be to support a training programme with the elements listed above.

- **Stockpiles and other relevant issues:** The current PTS project is collating existing information on chemical stockpiles and monitoring data. It was felt that the GEF should not wait until the completion of this project before moving to address any data gaps. Rather there should be a mechanism in a place to allow quick responses where there is a clear need for further work. This would include:

  - Containment and stabilization on existing stockpiles, where there was clearly an immediate hazard
  - Disposal of existing stockpiles (but as a lower priority, assuming secure condition)
  - Assessment of suspected stockpiles (e.g. where a country was known have imported large quantities of pesticides but had little or no knowledge of how these were being used)
  - Stabilization and disposal of created stockpiles (e.g. due to PCBs being withdrawn from use)
  - Basic monitoring, where a country was able to report significant imports and use but no useful monitoring data.

### 3.3 Persistent Toxic Substances (PTS) Management

- **Aspects of PTS Management:** It is important to recognize the relationship to land and soil management in many uses of PTS. Chemicals used on land can be washed into waterways, and hence into the sea. However, this can be minimized by effective land use controls and watershed management. There would be significant benefits in incorporating aspects of PTS management and use into land management research, and vice versa.

- **Methods of Treatment**: A potentially important targeted research area relates to the use of pilot studies into methods for the treatment of existing (regional) land contamination situations. (e.g. areas where there is known to widespread contamination as the result of previous DDT use).

- **PTS Behavior and Fate:** The development of regional models for PTS behaviour and fate was seen as a priority area for research. The term regional is used here in a geographical sense and could refer to areas ranging in size from river catchments and small inland seas, through to significant portions of continental areas with reasonably uniform climatic and

land use conditions. This work should be supported by adequate levels of monitoring for the purposes of model calibration and/or validation.

### 3.4 Potential Targeted Research Areas

- **Additive Models**: Development of additive models must be promoted for forecasting threshold concentration for chemicals in the presence of multiple stressors ;

- **Rapid Assessment Methodologies**: Development of low cost and easy-to-apply methodologies must be promoted for the rapid assessment of PTS and its metabolites in developing areas (environmental and human monitoring) and to obtain information on the ecological health of ecosystems ;

- **Regional Models**: Development of regional models and provision of information on emissions, degradation and persistence are needed for understanding PTS behaviour and fate ;

- **Characterization of Biogeochemical Behaviour**: Further investigations should be induced to characterise the biogeochemical behaviour of PTS in tropical areas and promote identification of exposure pathways in particular scenarios (malaria areas and hazardous waste areas) ;

- **Methodologies for Exposure Assessment**: New methodologies should be developed for exposure assessment in susceptible populations and more information must be provided on the risks derived from constant exposure to new PTS ;

- **Economic Tools**: Development of appropriate economic tools is required to value environmental assets and promote BEP (Best Environmental Practices), BAT (Best Available Technologies) and implementation of conservation actions ;

- **Policy Analysis Approaches**: Mechanisms and approaches must be devised to improve communication between scientists and policy makers to facilitate implementation of appropriate environmental policies.

Other potential targeted research highlighted included:

- Wildlife species sensitivity issues ;
- Multiple stressor issues
- Input data for chemical fate models ;
- Implementation of IPM techniques ;
- Country-specific BAT for dioxin emission ;
- Emission estimation methods.

### 3.5 Adequacy of the Current GEF Framework for Addressing POPs

Recognition was given to the fact that GEF has funded projects and activities related to the contamination of the environment by POPs. It was also noted that the Convention addresses twelve chemicals under the umbrella of "persistent organic pollutants" but leaves an open

channel for future inclusion of other chemicals that may be recognised, at a later stage, as persistent, toxic and of global concern.

In considering the existing GEF Framework for addressing POPs a number of observations and recommendations were made. These are summarised as follows:

- It is proposed that the approach suggested in UNEP's Regionally Based Assessment of Persistent Toxic Substances should be used as basis to selecting potential chemicals as candidates for GEF interventions. This implies:

  (i) the adoption of a more flexible definition of Persistent Toxic Substances (PTS) in which persistent and "mobile" may be listed as substances that are less inherently persistent but that lead to continuous exposure because of their constant release in the environment and wide spread use (ubiquity);

  (ii) to consider exposure patterns in defining relevance ;and

  (iii) to use chemical, ecotoxicological and human toxicological information ;

- It is recommended that GEF in dealing with chemical contamination should make use of regional prioritisation, looking for historical and cultural aspects when selecting important substances that will have to be dealt with at regional level. It is evident that there will be an increase in demand for investments in areas where GEF has not been active up to now. Moreover, actions in the context of POPs will have to be taken at country level.

- It was observed that OP 10 as currently written does not allow for a GEF response on a country by country basis. In addition, water is taken as the single pathway of exposure while in the case of POPs other routes are of far greater importance, and effects on land biota are not at all considered. The restriction related to a country-based action, cited above, means as for today relying on replications, an approach that shall inhibit GEF performance when undertaking a problem that is characterised by a diversity of peculiarities (country based: modes of use and storage of old stocks, different exposure routes, cultural and political context, etc.) and environmental conditions (regional aspects but in some cases country based). Dealing with the requirements of the POPs convention under OP 10 may restrict GEF actions in other issues of water contamination which are at least as important in developing regions. Some examples are chemical and pathogenic contamination of waters derived from sewage releases.

- A revision of OP 10 is recommended in the direction of:

  (iii) keeping the broad scope of GEF interventions in dealing with PTS other than the 12 POPs, and
  (iv) giving more emphasis to ephemeral contaminants (nutrient, etc) which are equally or even more damaging to the marine environment.

There was general agreement that the broadening of PTS/POPs issues beyond those specified in the existing OP 10 is warranted.

- It is also being recommended that a new OP is put in place to deal exclusively with the requirements emerging from the POPs Convention, in the event that GEF becomes the financial mechanism for the Convention. Such an OP should provide flexibility of action and a broad scope of interventions (addressing: human and environmental health issues, land and water ecosystems, technical and socio-economic aspects, actions on the ground for elimination or substitution).

- For an appropriate range of POPs/PTS issues to be addressed, the effects of this class of substances could not be limited to water pathways of exposure. For POPs/PTS to be dealt with holistically, all pathways of transport and exposure would need to be deemed relevant for GEF interventions.

- Though it was recognised that, for the purposes of the POPs convention, such additional substances would be those accepted by the Parties to the Convention, it was not considered desirable that a specific persistent toxic substance be identified for the purposes of defining their eligibility for GEF intervention, but instead the broad definitions of criteria for substances to be considered as PTS would suffice. Broadly inclusive criteria such as:

  - persistence (e.g > 6 months in soils)*
  - bioaccumulation (e.g. $\log k_{ow} > 10^3$)*
  - promoting adverse effects in humans or animals

  should be considered.

  (*drawn from the PDF-B Workshop for Regionally Based Assessment of PTS)

  The criteria should cover both broad-scale exposures and effects at population levels as well as adverse effects caused in sub-populations resulting from abnormally high exposures (through dietary peculiarities, for example). Both kinds of effects were believed relevant to the issue of PTS.

- The balance of activities covered by OP10 are circumscribed by contaminants derived from land-based activities, and contaminants derived from shipping. As a consequence, much effort is currently being devoted to problems associated with ballast water transport and exchange. The discussion therefore concentrated on contaminants derived from land based activities that are similar to those addressed within the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities concluded in Washington D C in November 1995.

  It was pointed out that GESAMP, in its currents reviews of the State of the Marine Environment to be published during 2000, has concluded that apart from climate change and over-fishing, the greatest causes of marine environmental damage and for threats to human health mediated by marine pathways of exposure are: nutrients introduction, sewage discharge, physical alteration including habitat destruction ; and sediments mobilisation (both augmentations and reductions). If these are considered in a GEF context, two are a problem because of their ubiquity and the nature of short range consequences (physical alteration and sewage). This raises questions about their eligibility under the current provisions of OP10. The other two topics (sediments mobilisation and nutrients

introduction) can have transboundary consequences on large-scale sedimentation / erosion patterns and in artificially enhanced primary production. However, on meso-scales and even sub-regional scales, marine nutrients are predominantly introduced from the atmosphere. This also makes the issue of questionable eligibility under provisions of OP10. In both cases (i.e. nutrients and sediment mobilisation) its actual scale of incremental effects is difficult to quantify although there are clearly demonstrated instances of such effects in the case of sediment impoverishment and some basis for defining scales of eutrophication.

Overall, it was concluded that there should be no withdrawal of eligibility or support for GEF interventions addressing either land-based or marine sources of contaminants and their effects irrespective of any re-profiling to support increased GEF interventions relating to POPs / PTS.

**Annex I**

**Brainstorming on Persistent Organic Pollutants (POPs)**
**January 17-18, 2000**
**Barbados**
**Preliminary Agenda**

**Preliminary Outline**

**Day 1**

| | |
|---|---|
| 9.00 a.m. - 10.00 a.m. | Official opening |
| 10.00 a.m. - 11.00 a.m. | Status of the Negotiations on POPs |
| 11.00a.m. - 11.30 a.m. | POPs and the GEF |
| 11.30 a.m. - 12.30 p.m. | *Monitoring biological effects using biomarkers: economic and technical advantages and limitations.* Prof. Michael H. Depledge, U.K.<br><br>Objectives:<br><br>• Present arguments that justify the need for monitoring<br>• Present a general overview of existing monitoring options (technical and economic)<br>• Present and discuss: technical and economical advantages, limitations and advances in monitoring through biomarkers. |
| 12.30 p.m. - 1.30 p.m. | Lunch |
| 1.30 p.m. - 2.30 p.m. | *Modelling and forecasting POPs environmental impact in developping countries*. Prof. Davide Calamari, Thailand<br><br>Objectives:<br><br>• Present a brief overview on the state of the art<br>• Data requirement<br>• Data and other missing information in developping countries that may impair the use<br>• How good modelling is compared to monitoring as a tool for environmental conservation policies<br>• Limitations |

2.30 p.m. - 3.30 p.m. *Overview on the global and regional significance of POPs: environmental and human health aspects*. Dr. Donald Tillitt, U.S.A <environmental aspects> ; Dr. Fernando Diaz-Barriga, Mexico <human health aspects>

Objectives:

- Present an overview on: PTSs of special concern and global or regional relevance, ecological and human toxicology aspects
- PTSs that are relevant in developing countries (as well as in transition economies), use patterns and sources
- Possible impacts on biodiversity and land degradation derived from PTS use, release or disposal

3.30 p.m. - 4.00 p.m. Coffee

4.00 p.m. -5.00 p.m. *Policy and options for PTS use in agriculture and vector control*. Dr. Shem Wandiga, Kenya

Objectives:

- Existing experiences on policies to address pest control
- Existing and future coming options (that perhaps need research activities) that may be economically and technically feasible in developing and transition countries
- Future challenges

5.00 p.m. - 6.00 p.m. *Availability of Techniques to reduce emissions of non-pesticide PTS* Dr. Hans-Ulrich Hartenstein, Germany

Objectives:

- Transfer of Technology
- Cost
- Availability in Developing Countries

**Day 2**

9.00 a.m. - 1.00 p.m. Consideration of specific issues. Arising out of the Presentation and their Implication for the GEF

- Is there a scope for regional capacity building ?
- Are old stocks and dumps a regional or global problem ? Alternative methods of destruction
- Is there a need for applied research addressing specific behaviour and fate under tropical climate ?

2.00 p.m. - 5.00 p.m. Which are the main bottle neck issues to implement best priorities related specifically to PTS? (Institutional, legal, economic, technical, public and/or governmental awareness, ordination?

Possible strategies for GEF intervention

- Is there a need for a new OP? If there is, what should be the scope?

**Annex II**

**STAP Brainstorming on Persistent Organic Pollutants (POPs)**
**February 21-22, 2000**
**Bridgetown, Barbados**

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